BRAIN COMPUTER INTERFACE

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PURPOSE OF PROJECT

The ultimate purpose of a BCI is to help disabled persons regain their ability to move, communicate, and control their environment.

ABSTRACT

A new means of communication between the human brain and a digital computer is the brain-computer interface (BCI). The ultimate restoration of mobility, communication, and environmental control for those with disabilities is the lofty objective of a BCI. A virtual reality system was integrated with an electroencephalogram (EEG) brain-computer interface to operate a smart home application. It provides a substitute for inborn control and communication. It is an artificial system that eschews the neuromuscular output channels, the body's typical efficient conduits. Different patterns of neuronal contact lead to different states of the brain. These patterns produce waves with various frequencies and amplitudes. The brain sensor picked up the signal that the brain produced, divided it into packets, and sent the packet data to a wireless media (blue tooth). The brain wave raw data will be received by the wave measuring unit, which will use the MATLAB GUI platform to turn it into a signal. Subsequently, the home section will receive instructions on how to use the modules (fan, lamp). Human brain activity was used in the experiment while the subject blinks their eyes. The robot's movement is controlled by this data.

INTRODUCTION

A novel means of communication for capturing human thought processes is the Brain-Computer Interface (BCI). Through the use of BCI, it is now possible to establish a direct line of communication between the human mind and machine by connecting brain activity to the functionality of computers and other devices. People with disabilities can increase their independence and optimise their capabilities at home by utilising BCI technology. The goal of this study is to improve the precision of robot control for those with disabilities. A new architecture for an EEG-based robot control system is presented in this research. People with movement limitations, such as those with paralysis or comparable conditions, will find this approach helpful. Wheelchair operation is challenging for those with disabilities if they don't have assistance.

HUMAN BRAIN

While the general structure of the human brain is similar to that of other mammals, the human brain has the most developed cerebral cortex of all. The brain's size is measured either by volume or by weight at different times.

For women, the average adult brain volume is 1130 cubic centimeters, whereas for men it is 1260 cubic centimeters.

An adult's brain weighs 1250 grams for women and 1360 grams for men; in contrast, a newborn baby's brain weighs only 350 to 400 grams. As people age and reach adulthood, their brain structure undergoes significant dynamic changes, with individual variations being significant. Men exhibit larger volume loss in the frontal and temporal lobes, as well as in the entire brain, in later decades, whereas women show is a greater loss of volume in the hippocampus and parietal lobes.

STRUCTURE OF BRAIN

The three primary components of the brain are the cerebrum, cerebellum, and brain stem, which are connected by the spinal cord. Every component, including the sensory, cognitive, and auditory parts, has a unique role.

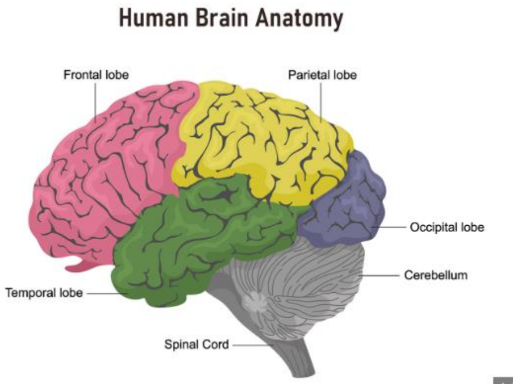


Figure 1. Parts of human brain

WAVES

A wave is an energy- transfering regular, repeating disruption of spacetime that doesn't include any net particle movement. There are two primary categories of waves: mechanical waves that need a medium to propagate, and electromagnetic waves that can pass through a vacuum. X-rays and microwaves are examples of electromagnetic waves, whereas seismic, sound, and ocean waves are examples of mechanical waves.

PROPERTIES OF WAVES

Amplitude: The wave's height, which is proportional to the energy it carries.

Wavelength: The separation of two sites that are the same in consecutive crest cycles.

Period: How long does it take a particle on a medium to go through one full vibrational cycle?

Frequency: The quantity of waves that pass a spot in a certain amount of time.

Speed: The distance that a specific point on the wave travels in a specific amount of time.

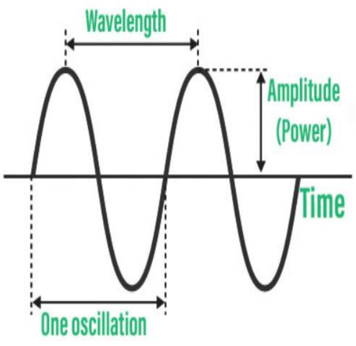


Figure 2. Waves

BRAIN WAVES

All aspects of brain function, including ideas, emotions, and behaviors, depend on brain waves, which are patterns of electrical activity. They are produced by the coordinated activity of neurons and are classified into many kinds according to their frequency and amplitude.

TYPES OF BRAIN WAVES

The frequency and amplitude of brain waves can be classified into four primary categories:

Alpha waves (8-12 Hz): These waves are linked to a calm but conscious state. When one's eyes are closed, they are most noticeable in the occipital area (visual cortex). It is believed that local interneurons, pyramidal cells that fire regularly, and thalamocortical loops are the sources of alpha waves.

Beta waves (14-30 Hz): These waves are associated to a state of alertness, focus, and intellectual activity. They are particularly prominent in the parietal and frontal regions of the head, where mental tasks take place. Beta waves are engaged in somatosensory processing and motor control.

Theta waves (4-7 Hz): These waves are linked to memory retention, light sleep, and day dreaming. They are visible in the parietal and temporal regions and are more noticeable in children and adolescents. It is believed that theta waves contribute to the inhibition of evoked responses.

Delta waves (0.5-3 Hz): Deep sleep is linked to these high-amplitude, low-frequency waves. Delta waves are generated in the cortex and are not influenced by activity in the brain's lower areas. They are believed to be involved in tissue regeneration and repair.

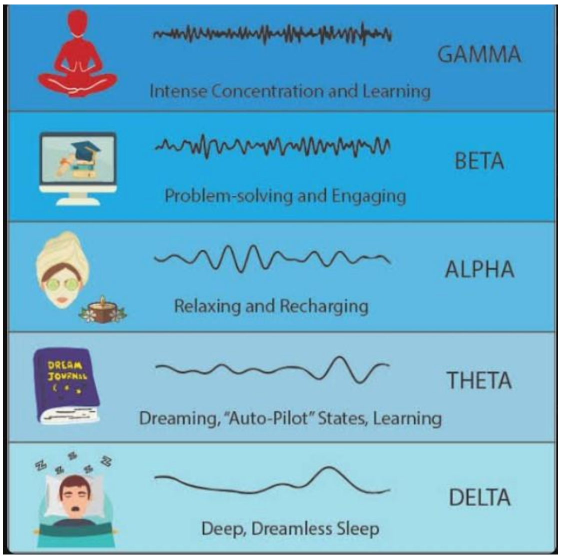


Figure 3. Types of Brain waves

NEURAL SYSTEM

An organism's nervous system is a sophisticated network of specialized cells called neurons that allow for coordination and communication. It is in charge of receiving and sending electrochemical impulses, which enables a number of processes including muscular control, cognitive processing, and sensory perception.

CRANINAL NERVE

The cranial nerves are a set of 12 pairs of nerves that originate in the brain and are responsible for various functions such as sensory perception, motor control, and autonomic functions. Each cranial nerve has a specific function and location in the brain, and they are identified by Roman numerals from I to XII.

Functions of Cranial Nerves

Olfactory Nerve (I): Responsible for the sense of smell.

Optic Nerve (II): Carries impulses for the sense of sight.

Oculomotor Nerve (III): Controls eye movement, pupil constriction, and extraocular muscles.

Trochlear Nerve (IV): Controls eye movement and superior oblique muscle.

Trigeminal Nerve (V): Responsible for somatosensory information from the face and head, as well as motor control of muscles for chewing

Abducens Nerve (VI): Controls eye movement and lateral rectus muscle.

Facial Nerve (VII): Responsible for taste (anterior 2/3 of tongue), somatosensory information from the ear, and facial expression.

Vestibulocochlear Nerve (VIII): Involved in hearing and balance.

Glossopharyngeal Nerve (IX): Responsible for taste (posterior 1/3 of tongue), somatosensory information from the tongue, tonsil, and pharynx, and motor control of swallowing.

Vagus Nerve (X): Involved in sensory, motor, and autonomic functions of viscera (glands, digestion, heart rate).

Accessory Nerve (XI): Controls muscles used in head movement.

Hypoglossal Nerve (XII): Controls muscles of the tongue

CLINICAL IMPORTANCE

Disorders: Cranial nerve disorders can cause a range of symptoms, including hearing loss, vision loss, facial paralysis, and difficulty swallowing.

Treatment: Radiation therapy, surgery, and other medical procedures are frequently used to address problems of the cranium.

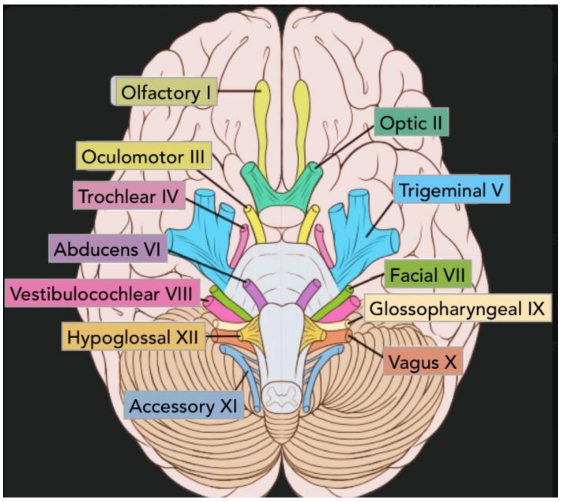


Figure 3. Parts of cranInal Nerve.

ELECTROMAGNETIC WAVES

One kind of energy that travels across the electromagnetic spectrum is known as electromagnetic wave. The oscillations between an electric field and a magnetic field are what produce them. These waves have a frequency and wavelength that allow them to pass through any material, including a vacuum.Electromagnetic waves travel at the same speed as light in a vacuum, or around 3 × 10^8 meters per second.

DEFINITION AND FORMATION

When an electric field and a magnetic field come into contact, electromagnetic waves are produced. As a result of this interaction, a wave with both electric and magnetic components is created. While the magnetic field oscillates in a direction perpendicular to both the electric field and the direction of propagation, the electric field oscillates in a direction perpendicular to the direction of propagation.

PROPERTIES

Frequency(HZ):Electromagnetic waves have a frequency that determines the number of oscillations per second. The unit of frequency is the Hertz.

Wavelength**:** The wavelength of a wave is defined as the separation between its successive peaks and troughs. The frequency and wavelength are inversely correlated.
Speed: Electromagnetic waves travel at the speed of light in a vacuum, which is approximately 3 x 10^8 meters per second.

BCI (BRAIN COMPUTE R INTERFACE)

Direct connection between the brain and a computer or other external devices is made possible by technology known as a brain-computer interface, or BCI. Through the detection and interpretation of brain impulses, it enables users to operate software and control devices just with their thoughts. BCIs can be used for a wide range of tasks, such as operating video games, doing brain research, and assisting those with disabilities.

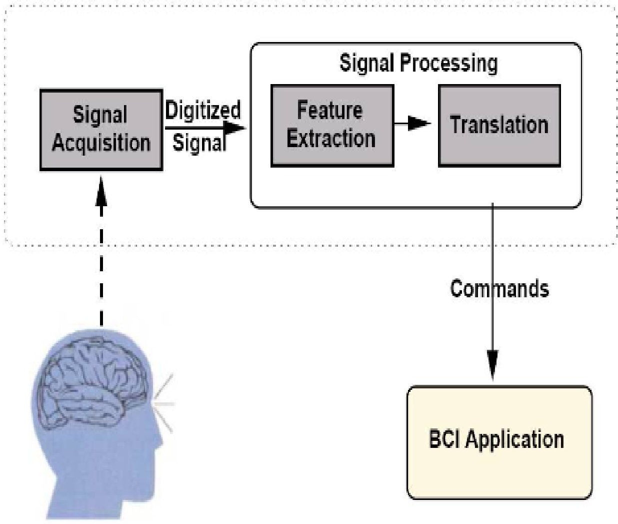


Figure 5. architecture of BCI

PHASES OF BCI

A Brain-Computer Interface (BCI) system's architecture usually consists of a number of interconnected parts that cooperate to provide brain-to-external device communication.

Signal Acquisition Model: The process of obtaining electroencephalography (EEG) data from the human brain is the initial stage of a BCI system. This is recording the electrical activity of the brain with electrodes and sending the recorded data to a processing unit.

Signal preprocessing: Before undergoing additional analysis, noise and artifacts in raw brain signals must frequently be eliminated or reduced. To improve the quality of the data, signal preprocessing techniques like filtering, artifact removal, and signal normalization are used.
Features Extraction: Relevant features are taken out of the preprocessed brain signals at this point. These features serve as input for the classification algorithms and capture significant aspects of brain activity. Time-domain, frequency-domain, and spatial-domain characteristics can all be extracted using feature extraction techniques.
Classification: Leveraging machine learning and statistical techniques to convert specific features into control commands.

Techniques: Linear Discriminant Analysis (LDA): Identifying a linear feature combination that distinguishes across classes.

Support Vector Machines (SVM)**:** Finding the optimal hyperplane that separates classes.

Artificial Neural Networks (ANN)**:** Pattern recognition with layers of networked neurons.

k-Nearest Neighbors(k-NN)**:** Organising according to the most similar training instances.

Electroencephalography (EEG)

An electroencephalogram, or EEG, is a test used to gauge the brain's electrical activity. It entails placing tiny metal discs on the scalp called electrodes, which are used to identify electrical impulses produced by brain cells. After that, these impulses are magnified and recorded on paper or a computer screen, enabling medical professionals to examine the electrical activity of the brain and identify different types of brain illnesses.

HOW ITS WORKS

The method by which Electroencephalography (EEG) functions is the detection and recording of electrical activity generated by brain neurons. This is a thorough explanation of how EEG works:

Electrode Placement: Standardised systems, like the 10-20 system, are used to implant electrodes on the scalp in a way that guarantees uniform and repeatable electrode placement for precise recording. These electrodes are usually attached to an amplifier and composed of conductive materials such as gold, silver, or tin.

Detection of Electrical Activity: The brain's neurons exchange electrical impulses with one another. Tiny electrical currents are produced when a group of neurons fires. The EEG electrodes are able to detect electrical fields created by these currents at the surface of the scalp.

Signal Amplification: Neuronal activity generates very small electrical signals, often in the microvolt (μV) range. The EEG machine amplifies these signals to a level at which they may be recorded and examined.

Data Recording: The EEG equipment records the electrical signals that have been amplified. On a computer screen, the data is typically shown as waveforms that illustrate the variations in electrical activity over time. The frequency (the speed at which the waves oscillate) and amplitude (the height of the waves) of these waveforms define them.

Signal Processing: To prepare the raw EEG signals for analysis, they go through a number of processing stages.

Filtering: Eliminating artefacts including electrical noise, twitches in the muscles, and blinks of the eyes.
Segmentation: Dividing the continuous EEG data into segments for analysis.

Feature Extraction: Identifying key features of the EEG signals, such as power in specific frequency bands, signal amplitude, and patterns.

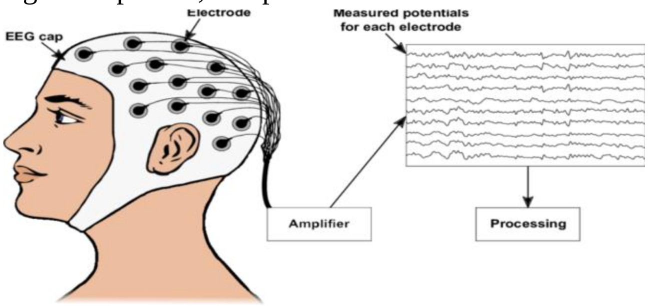


Figure 6. Implementation of BCI

Block diagram:

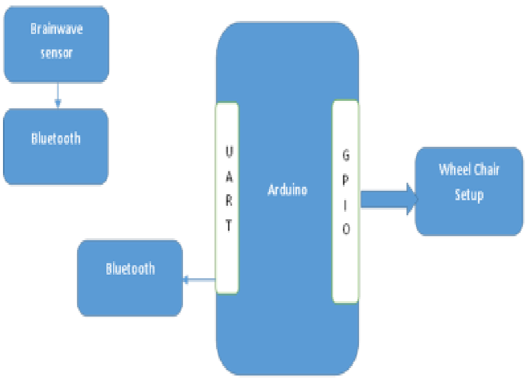


Figure 7. Block Diagram

Explanations

The electrical signals from the forehead position are captured by the BCI system. After that, the electrodes will transmit the signals to the amplifier and filter circuit, which amplifies the signal and filters out undesirable noise and signals. The Arduino's built-in ADC then transforms the analogue signals into digital signals. The electrical signals carry information on eye movement since they are obtained from the forehead position close to the eyes. From the received electrical signal, we can thus determine the number of eye blinks. The following logic is used by the micro controller to process the signals:

1. The EEG waves will peak whenever we blink.
2. The threshold value is established at this peak value.
3. The Arduino counts a blink if we blink and the ADC's output exceeds the threshold value.
4. The microcontroller's timer will begin to run the instant we blink.
5. The micro controller will activate the relay switches if we blink a predetermined number of times within a predetermined amount of time.

HARDWARE REQUIRED

Mind Wave Mobile Or Brainsensor

Arduino Uno/Mega

Bluetooth Module (HC-05)

Laptop or Pc

USB Cable for Arduino

SOFTWARE REQUIRED

Matlab 2024a (64 bit)

Arduino

HARDWARE DESCRIPTION

Mind Wave Mobile Or Brainsensor

Human-Computer Interfaces (HCI) are seeing a trend towards systems that can comprehend the various aspects of human communication and computer interaction. Brain-computer interface (BCI) is an HCI that is based on the guiding principle (GP) of "think and make it happen without any physical effort." The human brain is involved in the "think" portion of the GP, "make it happen" suggests the necessity for an executor (in this case, a computer), and "without any physical effort" indicates the requirement for a direct contact between the computer and the human brain. Brain activity must be monitored in order for the computer to understand what the brain is trying to say.

Arduino Uno

An open-source platform called Arduino is used to construct electronics projects. The Arduino system is comprised of a programmable circuit board, often known as a microcontroller, and an IDE (Integrated Development Environment) software that is installed on your computer and is used to develop and upload computer code to the board.
For good reason, the Arduino platform has grown in popularity among those who are just getting into electronics. In contrast to the majority of earlier programmable circuit boards, the Arduino may be updated with new code using a USB cable instead of a separate piece of hardware known as a programmer. Additionally, learning to programme is made simpler by the Arduino IDE's usage of a condensed version of C++. Last but not least, Arduino offers a standard form factor that separates the microcontroller's functions into a more approachable container.

Power (USB / Barrel Jack)

Each and every Arduino board requires a means of connecting to a power supply. You may power the Arduino UNO using a wall power source (like this one) or a USB connection that terminates in a barrel connector on your computer. The barrel jack is labelled (2) in the image above, while the USB connection is labelled (1).
You can also load code onto your Arduino board using the USB connection. See our Installing and Programming Arduino tutorial for more details on how to programme with Arduino.

Use of a power supply higher than 20 volts is NOT advised as this will overload your Arduino and cause it to malfunction. For the majority of Arduino models, a voltage of 6 to 12 volts is advised.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

To build a circuit, you attach wires to the pins on your Arduino (usually in conjunction with a breadboard and some wire). Typically, they feature "headers" made of black plastic that let you simply insert a wire into the board. There are various types of pins on the Arduino; each type is identified on the board and has a distinct purpose.

GND (3): An acronym for "Ground." The Arduino has multiple GND pins that you can utilise to ground your circuit.

3.3V (5) and 5V (4): The 5V pin provides 5 volts of electricity, as one might expect, and the 3.3V pin provides 3.3 volts. The majority of the basic parts used with the Arduino gladly operate on 3.3 or 5 volts.

Analogue (6): The pins on the UNO that are labelled "Analogue In" (A0 through A5) are Analogue In pins. These pins have the ability to read an analogue sensor signal (such as a temperature sensor) and translate it into a readable digital value.

Digital (7): The digital pins (0 to 13 on the UNO) are located across from the analogue pins. These pins can be used for digital output, such as powering an LED, and digital input, such as determining whether a button is pressed.

PWM (8): Some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO) may have had the tilde (~) adjacent to them. In addition to functioning as regular digital pins, these pins can be utilised for pulse-width modulation, or PWM. For the time being, consider these pins as having the ability to replicate analogue output (e.g., fading an LED in and out). We have a tutorial on PWM.

AREF (9): Analogue Reference is the acronym. For the most part, you may ignore this pin. Reset Button: It can occasionally be used to set an external reference voltage (between 0 and 5).

Power LED Indicator

On your circuit board, there's a small LED next to the word "ON" just below and to the right of the word "UNO" (11). Every time you plug your Arduino into a power source, this LED ought to turn on. It's likely that there's a problem if this light doesn't turn on. Time to examine your circuit again!.

TX RX LEDs

Transmit is shortened to TX, and receive is shortened to RX. In electronics, these markings are frequently used to identify the pins used for serial transmission. In our example, TX and RX are displayed twice on the Arduino UNO: once near digital pins 0 and 1, and again close to the TX and RX indication LEDs (12). When our Arduino is receiving or transferring data (such as when we're installing a new programme onto the board), these LEDs will provide us with some lovely visual cues.

Main IC

Integrated circuits, or ICs, are the black objects with all the metal legs (13). Consider it to be our Arduino's brains. The primary integrated circuit of an Arduino board varies slightly depending on the board type, although it typically comes from the ATMEL company's ATmega range of integrated circuits. This can be crucial since, before running a new programme from the Arduino software, you might need to know the IC type in addition to your board type. Usually, this information is written in writing on the IC's top side. Reading the datasheets is frequently a smart option if you want to learn more about the differences between different integrated circuits.

Voltage Regulator

Actually, you shouldn't (or can't) interact with the voltage regulator (14) on the Arduino. But knowing that it exists and for what purpose could be helpful. As stated, the voltage regulator regulates the voltage that is allowed to reach the Arduino board. Consider it to be a sort of gatekeeper, blocking any excess voltage that could damage the circuit. It has its limitations, of course, so don't connect your Arduino to any voltage higher than 20 volts.

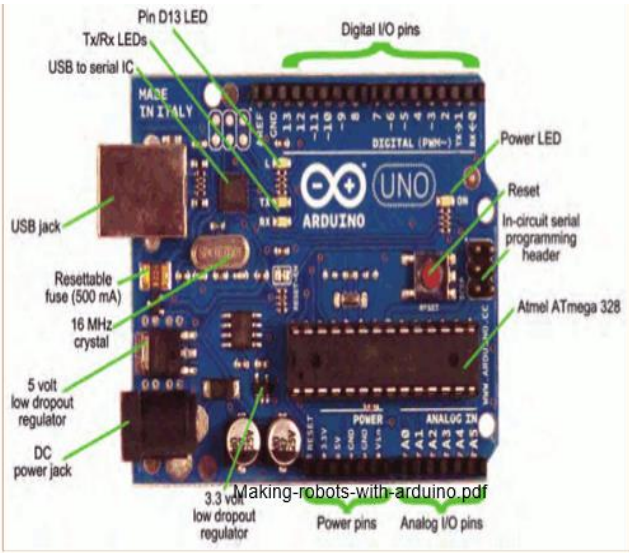


Figure 7. Arduino Uno

Bluetooth Module (Hc-05)

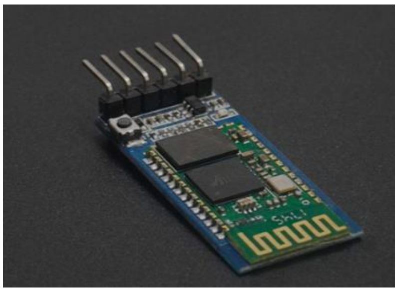


Figure 8. Bluetooth Module (HC-05)

Wireless headsets, game controllers, wireless mice, wireless keyboards, and numerous more consumer applications are just a few of the numerous uses for it.

Depending on transmitter and receiver, atmosphere, geography, and urban conditions, its range can be as little as less than 100 metres.

The standardised IEEE 802.15.1 protocol is used to create wireless Personal Area Networks (PANs). It transmits data over the air using frequency-hopping spread spectrum (FHSS) radio technology.

For device communication, it employs serial communication. It uses the serial port (USART) to connect with the microcontroller.

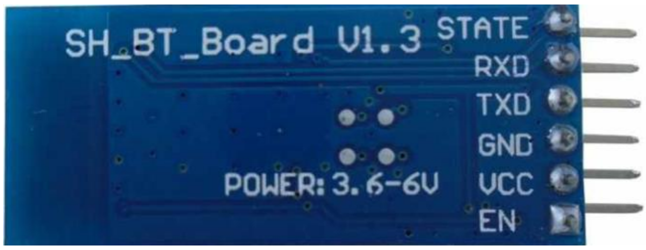


Figure 9. HC-05 Bluetooth Module Pin diagram

Pin diagram explanation

1. Key/EN: This key activates the AT commands mode on the Bluetooth module. When the Key/EN pin is in the high state, the module operates in command mode. If not, it is in data mode by default. The HC-05 has a default baud rate of 38400bps in command mode and 9600bps in data mode.
2. VCC: Attach either 3.3 V or 5 V to this pin.
3. GND: The module's ground pin.
4. TXD: Transmit Serial data (information obtained wirelessly by a Bluetooth module and serially sent via the TXD pin)
5. RXD: Receive data serially; a Bluetooth module will transfer the data wirelessly.
6. State: Indicates whether or not the module is connected.

HC-05 module Information

• The red LED on the HC-05 shows the connection state, whether Bluetooth is active or not. This red LED continually and periodically blinks before being connected to the HC-05 module. Its blinking slows down to two seconds when it connects to any other Bluetooth devices.
The module operates at 3.3V. Since the module contains a 5 to 3.3 V regulator on board, we may also attach a 5V supply voltage.
• There is no need to adjust the HC-05 Bluetooth module's transmit level because it has a 3.3V level for RX/TX and the microcontroller can detect that level. However, the transmit voltage level must be changed from the microcontroller to the HC-05 module's RX.

• Within a range of 10 metres, the HC-05 module's data transfer rate can fluctuate up to 1Mbps.

Specification of HC-05 Bluetooth Module:

- Bluetooth version: 2.0 + EDR (Enhanced Data Rate)
- Frequency: 2.4 GHz ISM band
- Modulation: GFSK (Gaussian Frequency Shift Keying)
- Transmit power: Class 2 (up to 4 dBm)
- Sensitivity: -80 dBm typical
- Range: approximately 10 meters (or 33 feet) in open air
- Profiles supported: SPP (Serial Port Profile), HID (Human Interface Device) and others
- Operating voltage: 3.3V to 5V DC
- Operating current: less than 50mA
- Standby current: less than 2.5mA
- Sleep current: less than 1mA
- Interface: UART (Universal Asynchronous Receiver/Transmitter)
- Baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, and 460800
- Operating temperature: -20°C to 75°C (-4°F to 167°F)

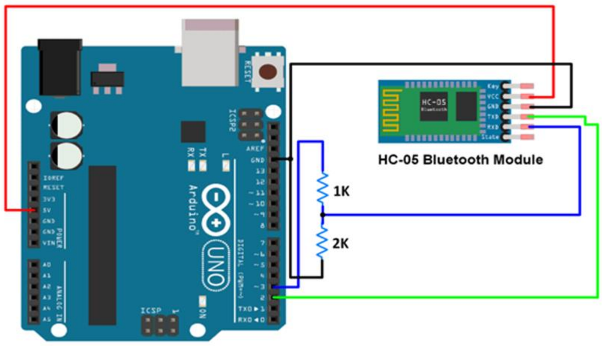
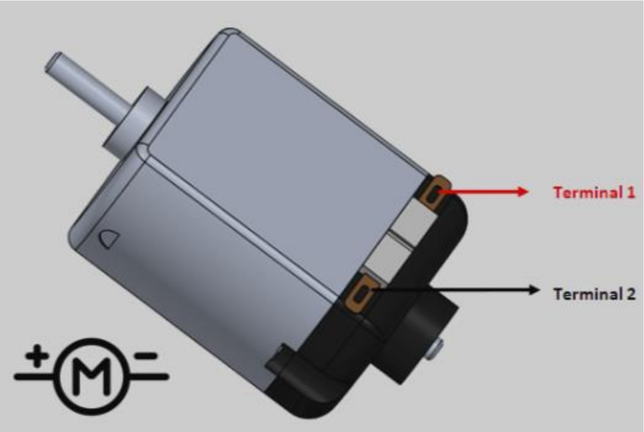


Figure 10. Bluetooth modulue interface with Arduino

Motor



An electric motor that is intended to run on a 5-volt direct current (DC) power source is known as a 5V DC motor. These motors' simplicity, cost, and versatility make them widely employed in a variety of applications. The following describes a 5V DC motor.

Operating Voltage: The voltage range in which a 5V DC motor operates is roughly between 4.5 and 6 volts DC. It is made specifically to run on a 5-volt power source, which is widely used in microcontrollers, electrical circuits, and battery-operated gadgets.

Construction: A 5V DC motor is normally made up of an armature (rotor), a field (stator), and a commutator. A wire coil inside the rotor creates a magnetic field as current passes through it. To produce a stationary magnetic field, permanent magnets or electromagnets are placed inside the stator, which encircles the rotor. Rotational motion is produced by the commutator and brushes, which help to transport electrical power to the rotor.

Speed and Torque: A 5V DC motor's speed and torque characteristics are determined by its design requirements, which also include the coil's number of windings, the magnetic field's strength, and the mechanical construction as a whole. Usually offering modest speed and torque, these motors are appropriate for a range of low-power applications.

Control and Direction: By switching the power supply's polarity, 5V DC motors can be made to operate in either direction or at a different speed using pulse width modulation (PWM) techniques. PWM control changes the input voltage's duty cycle to precisely regulate the motor speed. The motor rotates in a different direction when the polarity is reversed.

Applications: 5V DC motors are used in a wide range of electronic systems and devices, such as cooling fans, robots, toys, handheld gadgets, tiny appliances, and do-it-yourself projects. This is because of their small size and low voltage demand. They are frequently employed in activities that call for straightforward actuation or rotation.

MATLAB 2013B (32 BIT)

A high-performance language for technical computing is called MATLAB. It combines programming, computation, and visualisation into a user-friendly environment where issues and their fixes are presented using well-known mathematical symbols. Common applications consist of:

- Computation and math
- Algorithm development
- Modeling, simulation, and prototyping
- Scientific and engineering graphics
- Application development, including graphical user interface building.

An array is the fundamental data element in MATLAB, an interactive system that doesn't need to be dimensioned. This makes it possible to complete a lot of technical computing tasks more faster than you could if you were writing a programme in a scalar, noninteractive language like C or FORTRAN. This is especially true for problems involving matrix and vector formulations.

Matrix laboratory is what the word MATLAB stands for. The original purpose of MATLAB was to make matrix software produced by the LINPACK and EISPACK projects easily accessible. The software used by MATLAB today is the result of the LAPACK and ARPACK projects, which combined have produced the most advanced matrix calculation programme available.
With the help of numerous users throughout the years,

MATLAB has changed over time. It is the typical teaching aid in university settings for beginning and advanced science, engineering, and math classes. MATLAB is the preferred tool in industry for highly productive research, development, and analysis.

The term "MATLAB" refers to the matrix laboratory. MATLAB's original goal was to facilitate the easy access to matrix software created by the LINPACK and EISPACK projects. The most sophisticated matrix computation tool currently in use is the outcome of the LAPACK and ARPACK programmes, which collaborated to create the software that is utilised by MATLAB today.
Over the years, MATLAB has evolved with the assistance of many users. It is a common teaching tool used in university settings for maths, physics, and engineering courses at all levels. The industry standard tool for extremely productive research, development, and analysis is MATLAB.

The MATLAB System

The MATLAB system consists of five main parts:

Development Environment: This is the collection of resources and tools that facilitate the use of MATLAB files and routines. Graphical user interfaces are found in several of these tools. The MATLAB desktop and Command Window, a command history, and browsers for the workspace, files, search path, and help are all included.

The MATLAB Mathematical Function Library :This is a huge collection of computing algorithms that includes more difficult functions like matrix inverse, matrix eigenvalues, Bessel functions, and rapid Fourier transformations, as well as more basic functions like sum, sine, cosine, and complex arithmetic.
The MATLAB Language : Control flow statements, functions, data structures, input/output, and object-oriented programming capabilities are all included in this high-level matrix/array language. It enables "programming in the large" to develop comprehensive, large-scale, sophisticated application programmes as well as "programming in the small" to quickly create short, dirty, throw-away programmes.

Handle Graphics®. The MATLAB graphics system is this. High-level commands for image processing, animation, presentation graphics, and two- and three-dimensional data visualisation are included. It also contains low-level commands that help you create entire graphical user interfaces for your MATLAB applications and completely customise the look of graphics.
The MATLAB Application Program Interface (API): Using this library, you can create C and FORTRAN programmes that communicate with MATLAB. It has tools for reading and writing MAT files, calling MATLAB as a computational engine, and calling MATLAB routines (dynamic linking).

DEVELOPMENT ENVIRONMENT

An overview of MATLAB's startup and shutdown procedures, as well as the tools and functions that facilitate working with MATLAB files and variables, are given in this chapter. See the related topics under Development Environment in the MATLAB documentation, which is accessible both online and in print, for additional details on the subjects discussed here.

Starting and Quitting MATLAB

Starting MATLAB

Double-clicking the MATLAB shortcut icon on your Windows desktop will launch MATLAB on a Microsoft Windows platform.
To launch MATLAB on a UNIX platform, enter matlab at the prompt provided by the operating system. The MATLAB desktop appears once MATLAB is started; refer to MATLAB Desktop.
It is possible to modify the directory where MATLAB launches, specify startup parameters, such as launching a script at startup, and shorten starting times in specific circumstances.

Quitting MATLAB

You can either type quit in the Command Window or choose Exit MATLAB from the File menu on the desktop to exit your MATLAB session. You can write and run a finish.m script to do specific actions, such saving the workspace, every time MATLAB terminates.

MATLAB Desktop

The MATLAB desktop, which comprises graphical user interfaces (GUIs) for handling MATLAB-related files, variables, and applications, shows up when you launch the programme.
When MATLAB launches for the first time, the desktop looks like the picture below, albeit the items in your Launch Pad can be different.
The tools on your desktop can be opened, closed, moved, and resized to alter its appearance. Additionally, you have the option to dock tools, which allows you to move them inside or outside of the desktop. Common features like keyboard shortcuts and context menus are offered by all desktop tools. By choosing Preferences from the File menu, you can set specific parameters for the desktop tools. For instance, you can designate the font properties for text in the Command Window.

Desktop Tools

An introduction to MATLAB's desktop tools is given in this section. The majority of the capabilities included in desktop tools can also be accomplished with MATLAB functions. The implements are:

Command Window

Use the Command Window to enter variables and run functions and M-files.

Command History

The Command History window logs lines that you input in the Command Window. You can copy and run certain lines, as well as inspect previously used functions, under the Command History. Use the diary function to store the input and output from a MATLAB session to a file.

Running External Programs

From the MATLAB Command Window, external programmes can be executed. The character!, which is an exclamation point, is a shell escape that tells the operating system that the remainder of the input line is a command. This is helpful for launching other applications or utilities without having to exit MATLAB. For instance, in Linux, the command! emacsmagik.m launches the emacs editor for the file magik.m. MATLAB regains control of the operating system after you exit the external programme. The Launch Pad in MATLAB makes tools, demonstrations, and documentation easily accessible.

Help Browser

To search through and see documentation for any of your Math Works products, use the Help browser. The Help browser is an HTML document-viewing Web browser that is built into the MATLAB desktop. You can type help browser in the Command Window or click the help button in the toolbar to launch the help browser. The Help Navigator is where you look for information in the Help browser, and the display pane is where you see the information.

Help Navigator

Use to Help Navigator to find information. It includes:

Product filter - To view documentation solely for the goods you designate, set the filter accordingly.

Contents tab - View the product documentation's titles and table of contents.

Index tab - Locate particular index entries (chosen keywords) in the MathWorks product documentation.

Search tab - Look through the documentation for a certain phrase. Set the Search type to Function Name to obtain assistance for a particular function.

Favorites tab - See a list of the documents that you have marked as favourites.

Display Pane - View the documentation in the display pane after locating it with the Help Navigator. As you look over the documentation, you can:

Browse to other pages - Utilise the toolbar's back and forward buttons or the arrows at the top and bottom of the pages.

Find a term in the page - Click Go after entering a phrase in the toolbar's "Find in page" field. The display window also allows you to examine Web pages, evaluate selections, and copy information.

Current Directory Browser - The current directory and the search path are used as reference points in MATLAB file operations. Any file you wish to execute needs to be on the search path or in the current directory.

Search Path - MATLAB employs a search path to locate M-files and other MATLAB-related files, which are arranged in directories on your file system, to determine how to execute functions you call. You can't launch any file in MATLAB unless it's in the current directory or one of the search path's directories. The MATLAB and MathWorks toolbox files are automatically added to the search path.

Workspace Browser - The collection of variables (referred to as arrays) assembled during a MATLAB session and kept in memory makes up the MATLAB workspace. By using functions, executing M-files, and loading stored workspaces, you can add variables to the workspace.
Use the who and whos functions, or the Workspace browser, to see the workspace and details about each variable.
Select the variable and choose Delete from the Edit menu to remove it from the workspace. As an alternative, employ the obvious function

Array Editor - To view a variable in the Array Editor, double-click on it in the Workspace browser. To see and modify a visual representation of strings, cell arrays of strings, and one- or two-dimensional numeric arrays in the workspace, use the Array Editor.

Editior - To build and debug M-files—programs you write to run MATLAB functions—use the Editor/Debugger. The Editor/Debugger offers a graphical user interface for both M-file debugging and simple text editing.
Any text editor, such as Emacs, can be used to create M-files. The default editor can be set using preferences, which are accessed through the desktop File menu. You can still debug with the MATLAB Editor/Debugger if you use a different editor, or you can utilise debugging tools like dbstop, which creates a breakpoint.

RESULT

CONCLUSION

With the use of this suggested method, signals were transmitted from the headset to the Arduino so that the wheelchair would move in response to brain inputs. Wheelchair control is possible with the implementation of the hardware architecture mentioned above. Two motors are used by this wheelchair to move it. This system is a step towards brain-controlled movement, despite its extreme rawness. The wheelchair's mobility will only be adjusted in response to signals produced by the mind. Modules that are user-based or customised can be made, creating a distinct footprint. It makes use of cutting-edge, constantly developing technology that makes iterations simple and easy to handle. Despite their extremely low cost, the components offer optimal performance. Those with upper torso paralysis may need assistance from outside sources to place or adjust their headset. The existing headgear cannot measure precise thoughts.

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